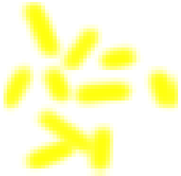

P-TRAP: Panicle Traits Phenotyping Tool

User Manual

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http://bioinfo.mpl.ird.fr/index.php?option=com_content&view=article&id=67&Itemid=78

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Chapter 1

Installation and Main Components

1 Introduction

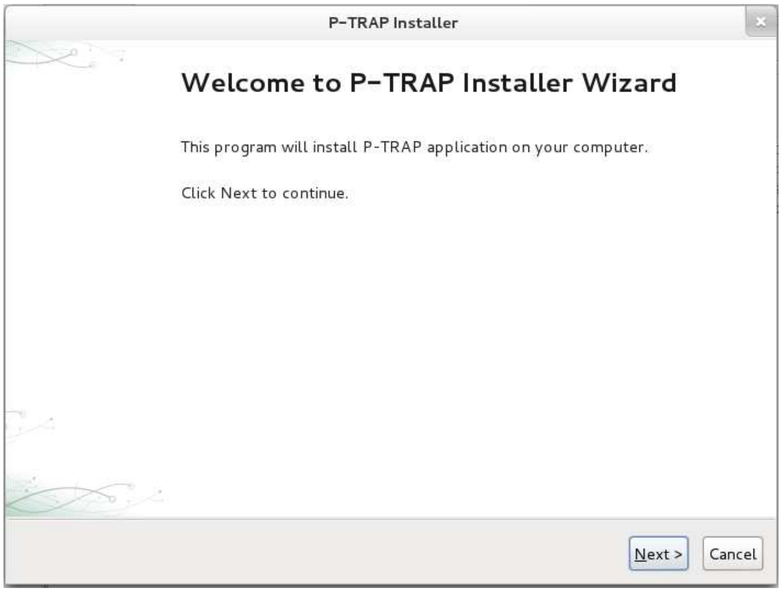
P-TRAP is an application for analyzing plant panicle images. It is a cross-platform application developed in Java and designed on top of Netbeans Platform 7.1. It allows the user to process the images in a project-based approach. The images to be processed are added to a project and when analyzed, the intermediary results are saved in separate files. The final results can be collected in master and details files. Additionally, The panicle structure and the grains are stored in XML files which can be exported to be used by other applications. Besides this manual, several video tutorials can be found in the application website.

1.1 System Requirements

1. System: Platform-independent

2. Processor: Core 2 Due or higher

3. Memory: 2 GB or more



Welcome to P-TRAP Installer Wizard

This program will install P-TRAP application on your computer.

Click Next to continue.

Figure 1: The Linux installation window of P-TRAP

1.2 Installation

1.2.1 Linux

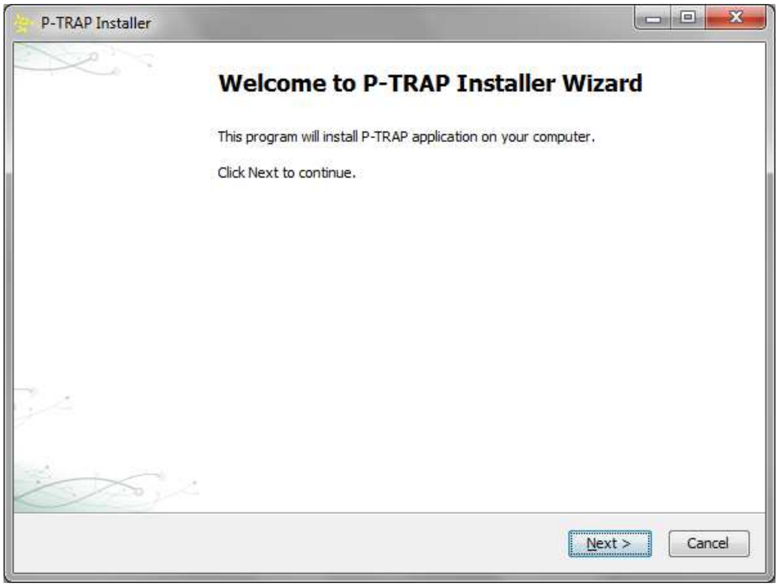
Open the terminal, go to the folder where the *grain-linux.sh* is located and type: *sh grain-linux.sh* The installer window will then appear, Figure 1. Once you press *Next* button, the installer will ask you where to put the application and its shortcuts.

1.2.2 Windows

In Windows operating system, locate the file *grain-windows.exe* and open it. The installer, Figure 2, will open, click *Next* button and follow the on-screen simple instructions.

1.3 The Main Window

The main window of P-TRAP is shown in Figure 3. This window has three main areas as explained in this figure.

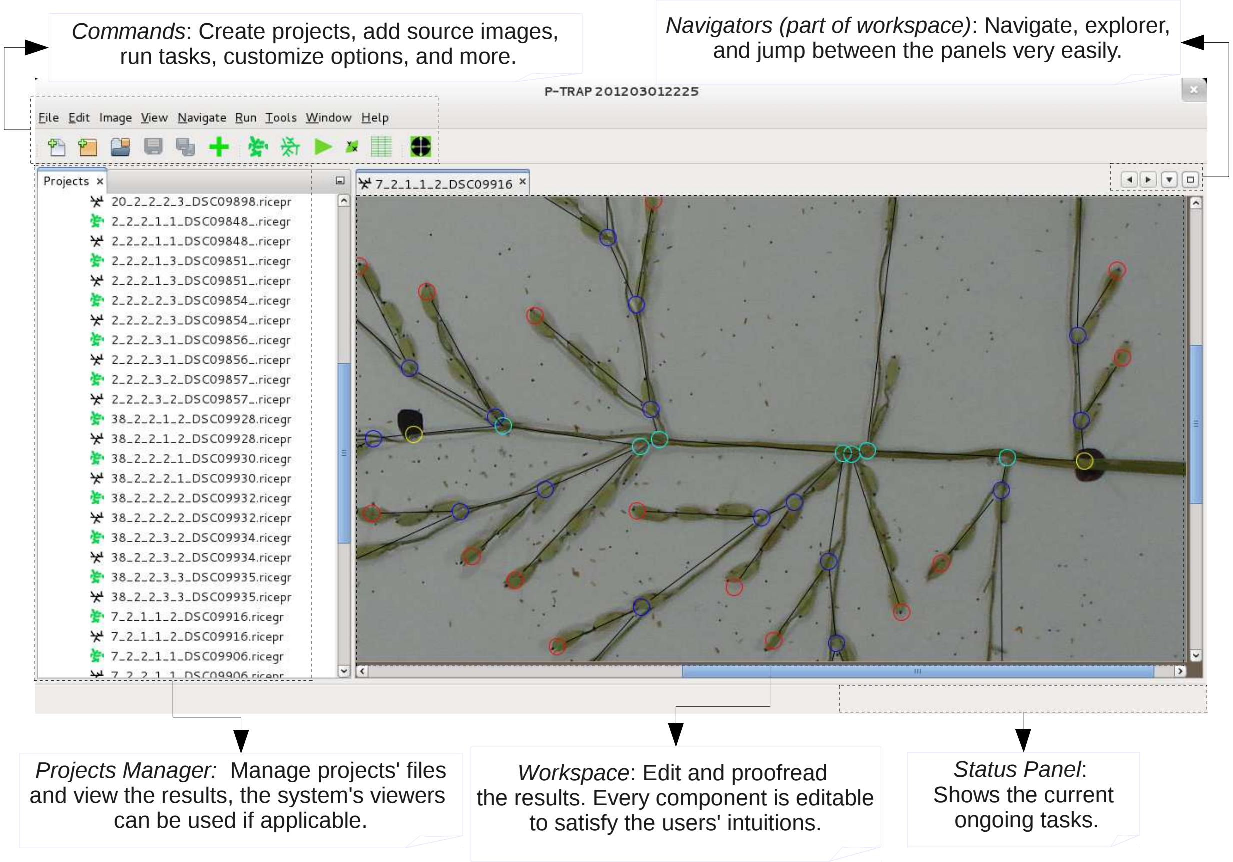

P-TRAP Installer
Next >
Cancel

Welcome to P-TRAP Installer Wizard

This program will install P-TRAP application on your computer.

Click Next to continue.

Figure 2: The Windows installation window of P-TRAP


P-TRAP 201203012225
File Edit Image View Navigate Run Tools Window Help
Projects ×
20_2_2_2_3_DSC09898.ricepr
2_2_2_1_1_DSC09848_.ricegr
2_2_2_1_1_DSC09848_.ricepr
2_2_2_1_3_DSC09851_.ricegr
2_2_2_1_3_DSC09851_.ricepr
2_2_2_2_3_DSC09854_.ricegr
2_2_2_2_3_DSC09854_.ricepr
2_2_2_3_1_DSC09856_.ricegr
2_2_2_3_1_DSC09856_.ricepr
2_2_2_3_2_DSC09857_.ricegr
2_2_2_3_2_DSC09857_.ricepr
38_2_2_1_2_DSC09928.ricegr
38_2_2_1_2_DSC09928.ricepr
38_2_2_2_1_DSC09930.ricegr
38_2_2_2_1_DSC09930.ricepr
38_2_2_2_2_DSC09932.ricegr
38_2_2_2_2_DSC09932.ricepr
38_2_2_3_2_DSC09934.ricegr
38_2_2_3_2_DSC09934.ricepr
38_2_2_3_3_DSC09935.ricegr
38_2_2_3_3_DSC09935.ricepr
7_2_1_1_2_DSC09916.ricegr
7_2_1_1_2_DSC09916.ricepr
7_2_2_1_1_DSC09906.ricegr
7_2_2_1_1_DSC09906.ricepr
7_2_1_1_2_DSC09916 ×

Commands: Create projects, add source images, run tasks, customize options, and more.

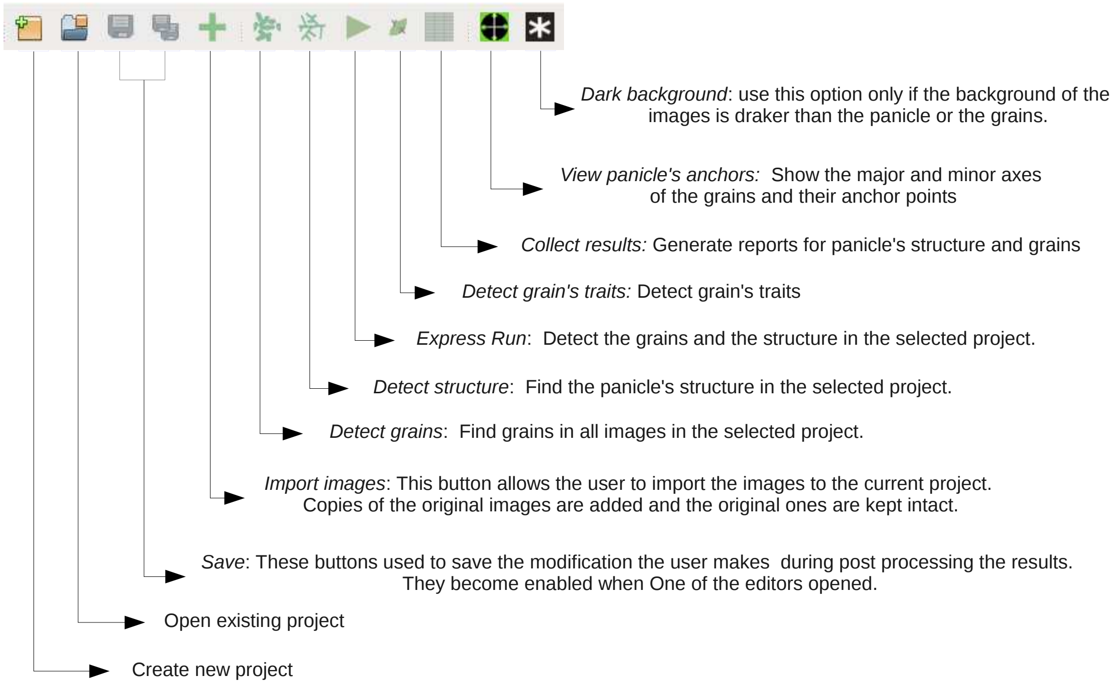
Navigators (part of workspace): Navigate, explorer, and jump between the panels very easily.

Projects Manager: Manage projects' files and view the results, the system's viewers can be used if applicable.

Workspace: Edit and proofread the results. Every component is editable to satisfy the users' intuitions.

Status Panel: Shows the current ongoing tasks.

Figure 3: The main window of P-TRAP.



Dark background: use this option only if the background of the images is draker than the panicle or the grains.

View panicle's anchors: Show the major and minor axes of the grains and their anchor points

Collect results: Generate reports for panicle's structure and grains

Detect grain's traits: Detect grain's traits

Express Run: Detect the grains and the structure in the selected project.

Detect structure: Find the panicle's structure in the selected project.

Detect grains: Find grains in all images in the selected project.

Import images: This button allows the user to import the images to the current project. Copies of the original images are added and the original ones are kept intact.

Save: These buttons used to save the modification the user makes during post processing the results. They become enabled when One of the editors opened.

Open existing project

Create new project

Figure 4: The toolbar of the main window.

1.3.1 Commands

In the *commands* area, the tool bar has several buttons with different functionalities explained in Figure 4

1.3.2 Project Manager

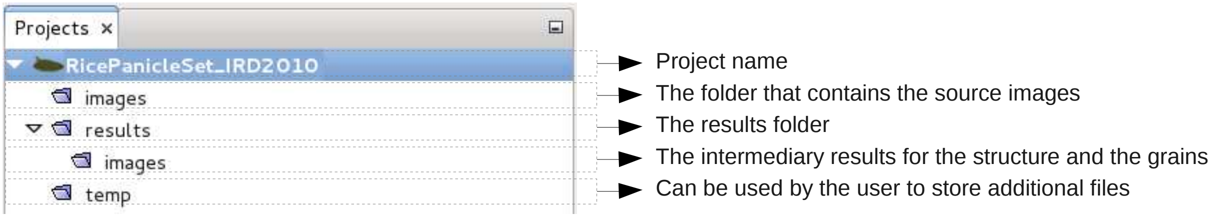
In this area, Figure 5, all files and folders in the project can be dealt with very easily. A context menu (right-clicked menu), Figure 5b, can be used to manage the files.

1.3.3 Workspace

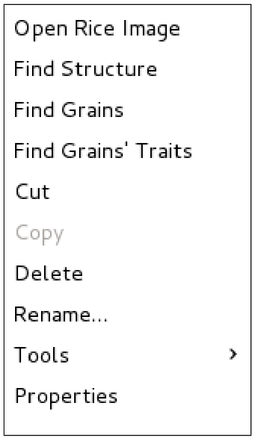
In Workspace, the user can view and edit: images, structure and grains' results. In this area, specialized editors for the images, structure and grains are available. These editors share the same commands for zooming and moving the scene[1]. The *ImageEditor*, Figure 6, allows the user to select the region-of-interest and crop the image, Figure 6.

---

[1] In the editor, the scene is the entire area where the user can work


Projects
RicePanicleSet_IRD2010
images
results
images
temp
Project name
The folder that contains the source images
The results folder
The intermediary results for the structure and the grains
Can be used by the user to store additional files

(a) Project components


Open Rice Image
Find Structure
Find Grains
Find Grains' Traits
Cut
Copy
Delete
Rename...
Tools
Properties

(b) Project components menu

Figure 5: P-TRAP project folders.

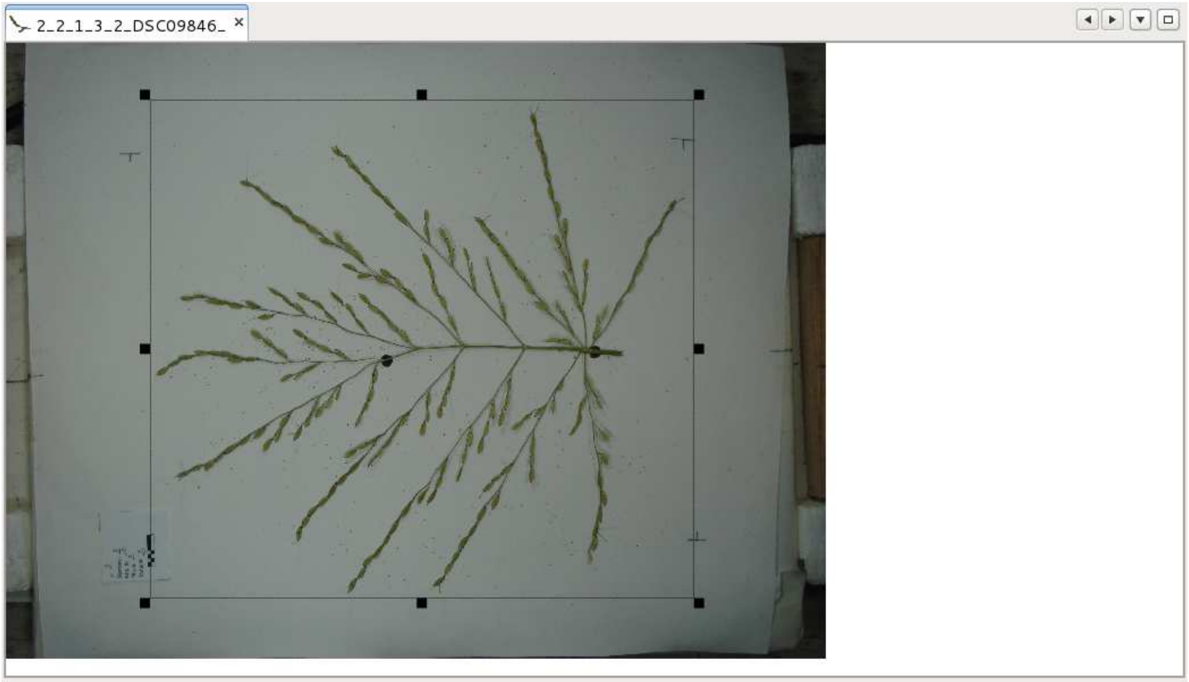
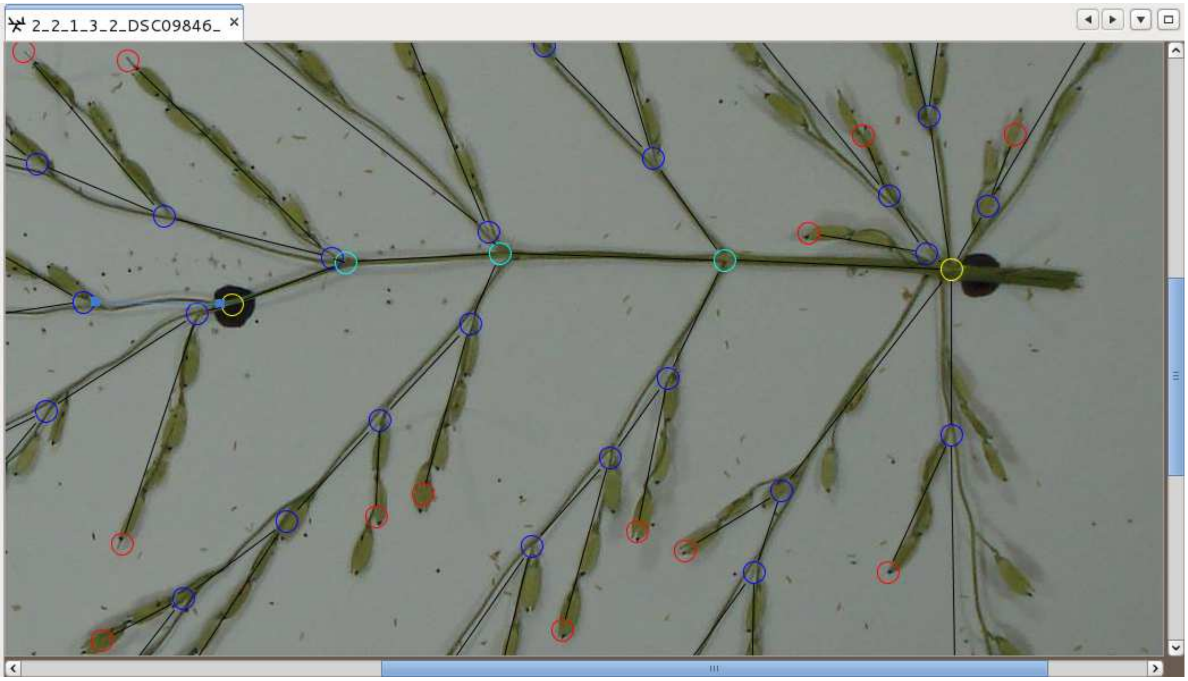
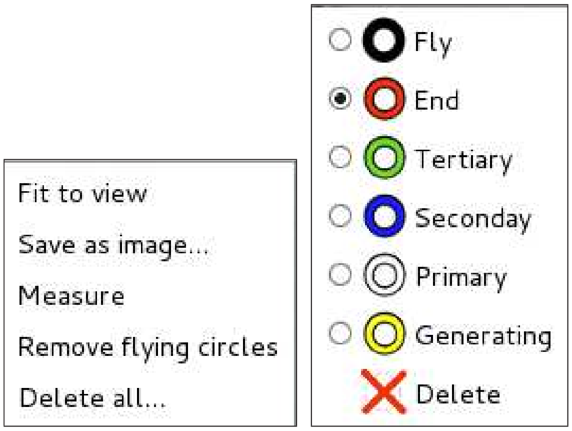

2_2_1_3_2_DSC09846_

Figure 6: The images editor.


2_2_1_3_2_DSC09846_

(a) Structure editor

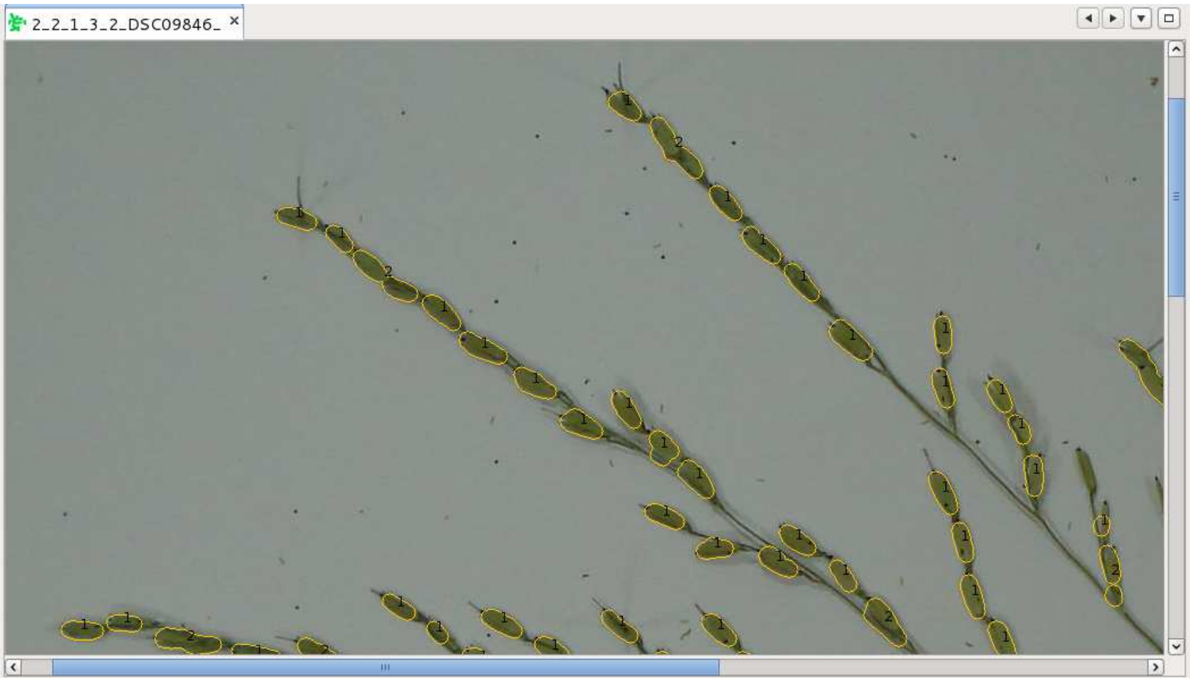

Fit to view
Save as image...
Measure
Remove flying circles
Delete all...
○ Fly
● End
○ Tertiary
○ Seconday
○ Primary
○ Generating
Delete

(b) Structure editor menu (c) Structure components menu

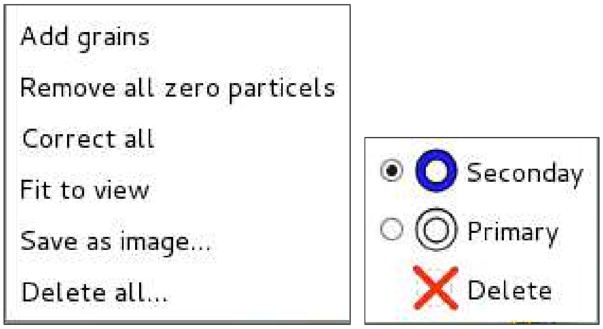
Figure 7: The panicle structure editor.

In order to crop the image, first select the area where the panicle is, then click *save*. button. By using the handles of the cropping frame the user can easily choose the exact area to be crop out.

This editor is used for both editing the grains detected on the branches of the panicle or the grains used for detecting grains' traits, Figure 9.


2_2_1_3_2_DSC09846_

(a) Grain editor


Add grains
Remove all zero particels
Correct all
Fit to view
Save as image...
Delete all...
● Seconday
○ Primary
Delete

(b) Grain editor menu (c) Grains menu

Figure 8: The grains editor.

2 Files

In this section, the files that the application works with and generates are described. These files are described and shown in Figure 10.

2.1 Images

The application works on most of the well-known image formates. It supports both the colored and grayscale images. For better performance, it is better to scale the images as we will see in

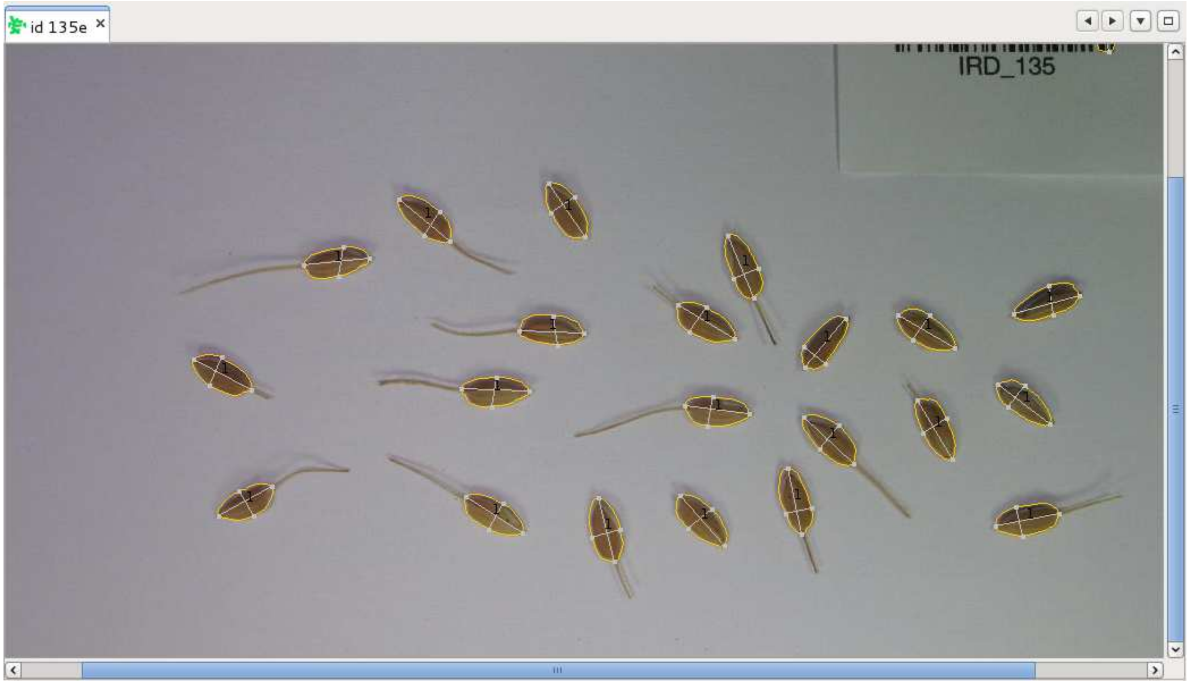
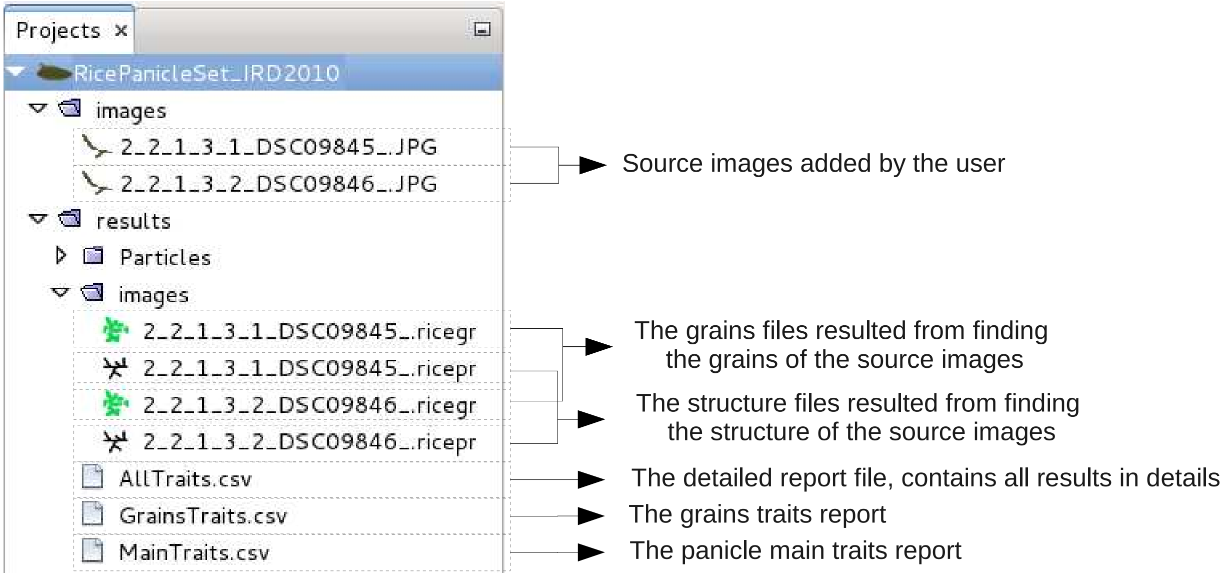

id 135e
IRD_135

Figure 9: The grains editor can be also used for editing separated grains.


Projects
RicePanicleSet_IRD2010
images
2_2_1_3_1_DSC09845_.JPG
2_2_1_3_2_DSC09846_.JPG
results
Particles
images
2_2_1_3_1_DSC09845_.ricegr
2_2_1_3_1_DSC09845_.ricepr
2_2_1_3_2_DSC09846_.ricegr
2_2_1_3_2_DSC09846_.ricepr
AllTraits.csv
GrainsTraits.csv
MainTraits.csv

Source images added by the user

The grains files resulted from finding the grains of the source images

The structure files resulted from finding the structure of the source images

The detailed report file, contains all results in details

The grains traits report

The panicle main traits report

Figure 10: The files that P-TRAP uses/produces.

Section 2.6.

2.2 Structure and Grains Files

The structure and the grains of the panicle are stored in XML files. These files can be used by other applications. If you are interested to use them in your application please see Appendix A. In fact, the P-TRAP's editors described earlier uses these files to visualize the results and allow the user to visually post-process them. These files are shown in Figure 10.

Chapter 2

Working with P-TRAP

1 Introduction

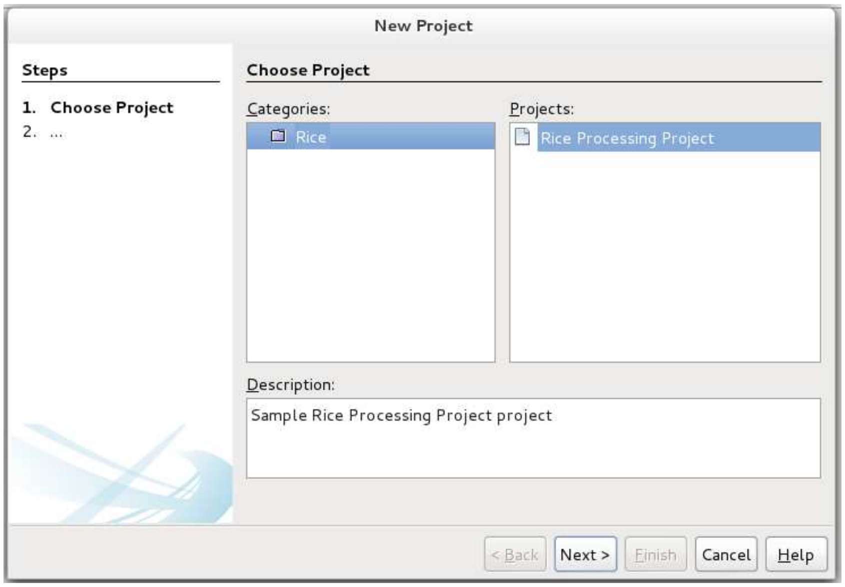
This chapter provides a step by step illustration for using P-TRAP. It is divided to a set of examples. In each one a specific task is addressed and explained. The work with P-TRAP is very simple. The idea is to create a project that contains several images with the same scale and background intensity (*i.e* dark or light background). Then process the project with options suitable for its images.

2 Tasks

2.1 Getting Started

In this section, the creation of a new project is explained. To create a project do the following:-

1. Open the application
2. Click on the *New Project* button in the tool bar
3. In the *New Project* wizard, Figure 1, choose *Rice Processing Project* and click *Next* button.
4. Specify a name and where the project will be stored, Figure 2.


New Project
Steps
Choose Project
< Back
Next >
Finish
Cancel
Help

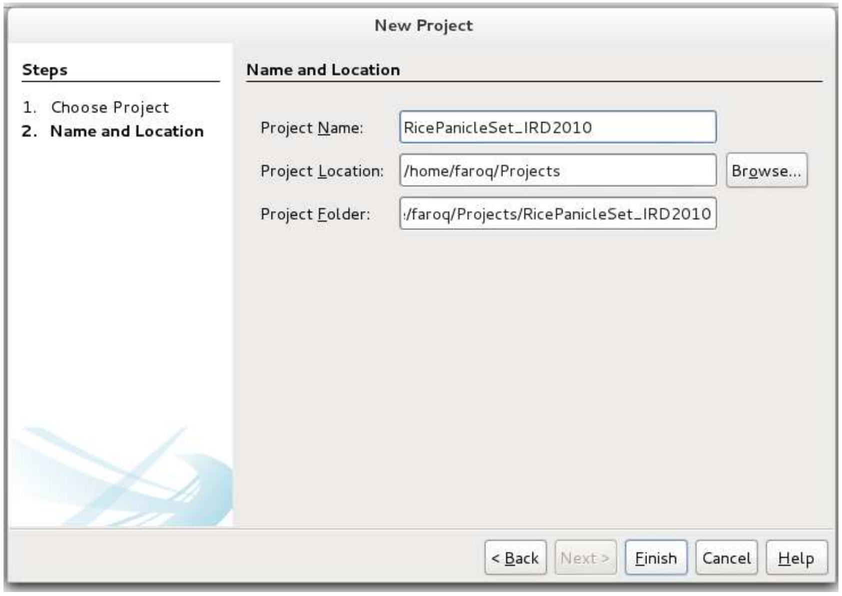
1. Choose Project
2. ...

Categories: Rice

Projects: Rice Processing Project

Description: Sample Rice Processing Project project

Figure 1: The *New Project* dialog: Select the project type


New Project
Steps
Name and Location
Browse...
< Back
Next >
Finish
Cancel
Help

1. Choose Project
2. Name and Location

Project Name: RicePanicleSet_IRD2010

Project Location: /home/faroq/Projects

Project Folder: :/faroq/Projects/RicePanicleSet_IRD2010

Figure 2: The *New Project* dialog: Name and location of the project

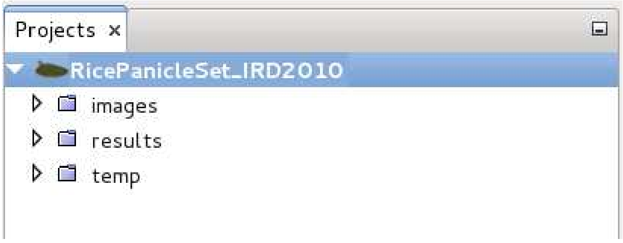
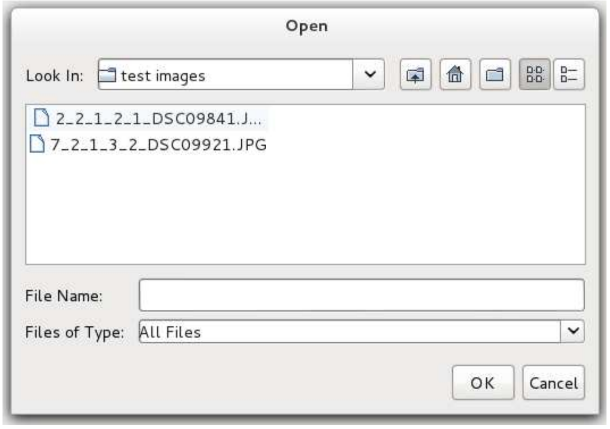


Figure 3: A new project named "RicePanicleSet_IRD2010" is created



Look In: test images

2_2_1_2_1_DSC09841.J...
7_2_1_3_2_DSC09921.JPG

File Name:

Files of Type: All Files

Figure 4: The *Open* dialog: Add images to the project

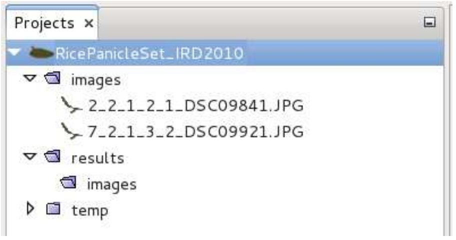
5. Click *Finish*.

A new project will be then created as shown in Figure 3.

2.2 Adding Images to P-TRAP

In this step one or more images will be imported to the project. To do that, follow these steps:-

1. Click on the *Import Images* + button in the toolbar
2. In the *Open* dialog, Figure 4, locate your images files and click *OK*. You can choose single or multiple files to add to the project. Hold *ctrl* or *shift* keys during clicking on the files to select/deselect multiple file. To select all files, press *ctrl+A* key combination.
3. Click *OK*, the image will be added to the *images* folder in the project, Figure 5.
4. Click finish.



Projects ×
RicePanicleSet_IRD2010
images
2_2_1_2_1_DSC09841.JPG
7_2_1_3_2_DSC09921.JPG
results
images
temp

Figure 5: New images are imported to the project.

It is important to note, at this point P-TRAP does not uses the original images. Instead, it imports a copy of the original ones. So the original images are kept intact.

2.3 Working with Images

This step has some optional tasks if your images do not have huge size (we consider more than 1024 × 1024 as a big image) and do not have labels or additional hand-made marks.

2.4 View the Source Images

To view an image you can do one of the following:-

1. Double click on the image file in the project, or
2. Right click on the image, a context pop-up menu appears, choose *Open Rice Image*, Figure 5b.
3. The *Image Editor* will then open the image and let you tweak it, Figure 6.
4. Hold the *ctrl+mouse wheel* to zoom in/out the scene, Figure 7. Please note that, this key/mouse combination can be used in all editors in P-TRAP to perform the zoom in/out task.

Besides, this editor has a popup menu to select the color of the grain and background. This is be used in grain detection task later on this chapter.

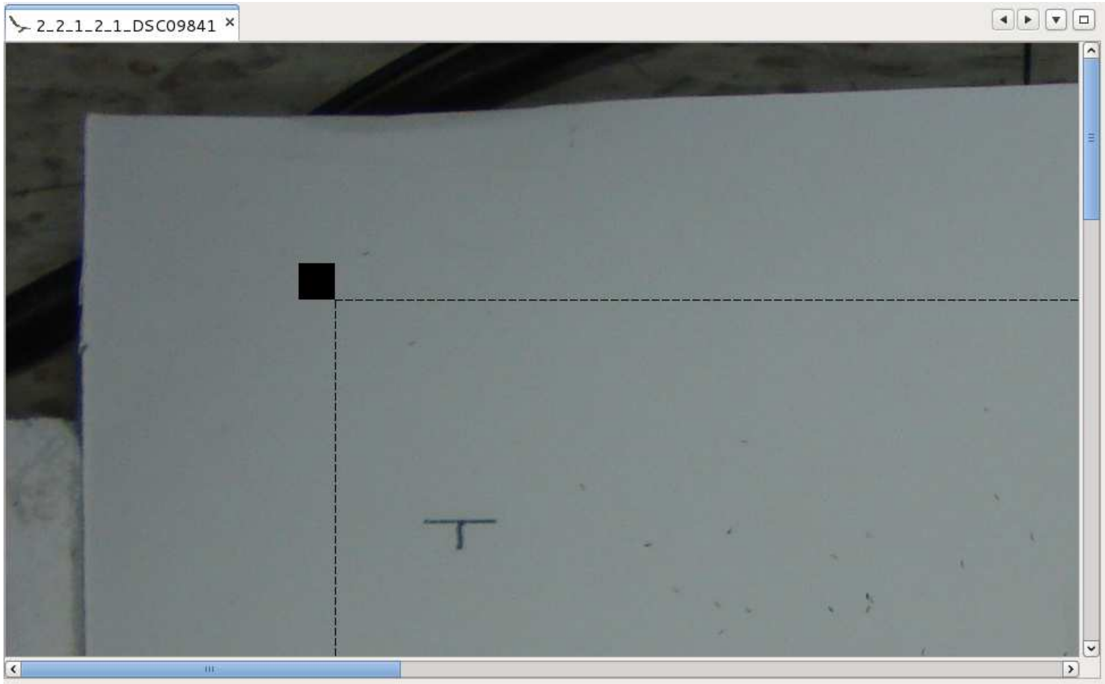

2_2_1_2_1_DSC09841

Figure 6: View/edit image in the Image Editor.

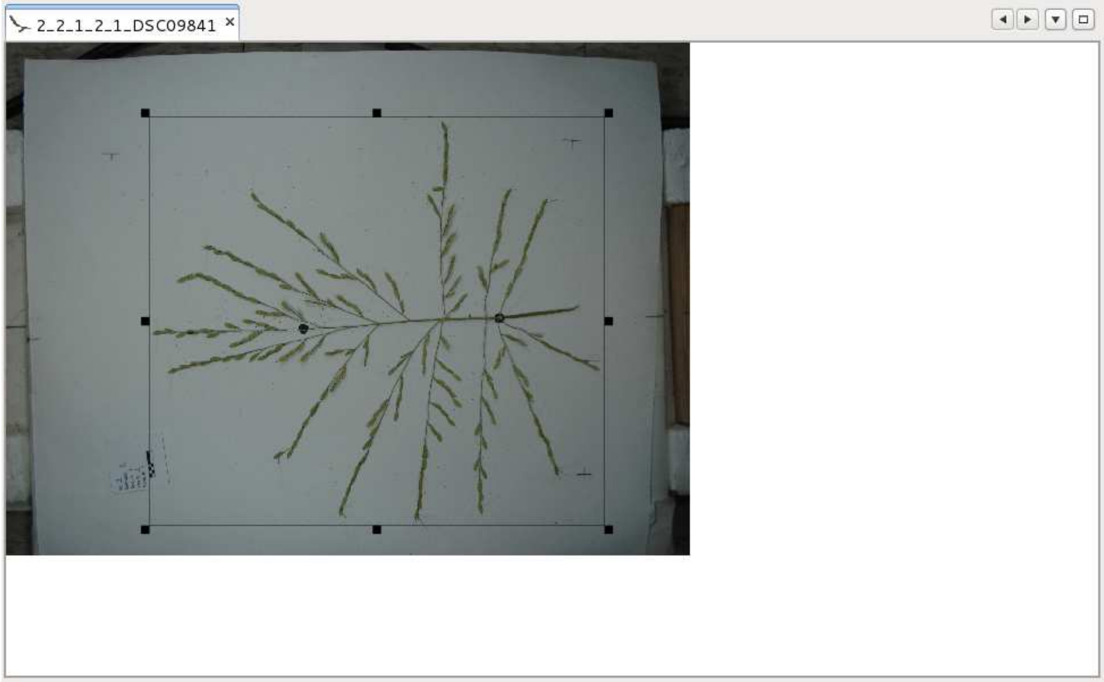

2_2_1_2_1_DSC09841

Figure 7: Zoom in/out in the scene in the Image Editor

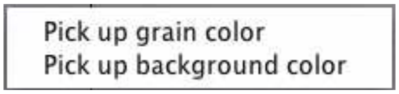
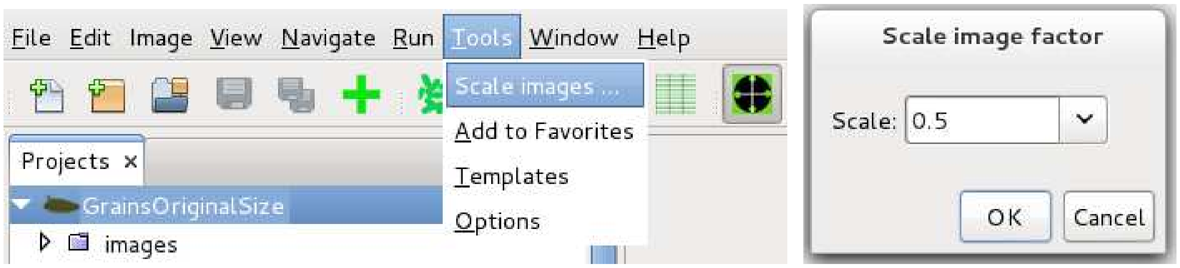

Pick up grain color
Pick up background color

Figure 8: Image editor menu.


File Edit Image View Navigate Run Tools Window Help
Scale images ...
Add to Favorites
Templates
Options
Projects
GrainsOriginalSize
images
Scale image factor
OK
Cancel

Scale: 0.5

(a) Scale images command (b) Scale images factor dialog

Figure 9: Scale images in a selected project

2.5 Crop an Image

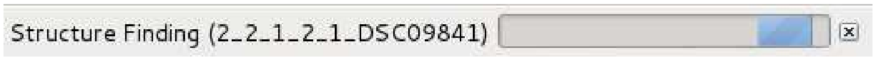
1. Select the cropping area on the image by using the movable and resizable frame, see Figure 7.
2. Click 💾.

2.6 Scaling Images

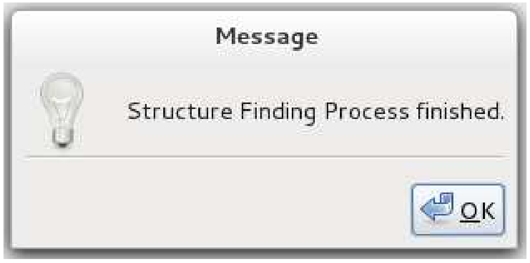
This step allows you to scale your images if they have huge or very small sizes, otherwise it is not necessary. To scale images do the following:

1. Select the project name.
2. Go to the *Tools* menu and select *Scale images*, Figure 9a.
3. In the scaling dialog, choose the scale factor depending on the scale you want to work with and click *OK*, Figure 9b.

Usually, 1024×1024 images are enough for good processing. However, huge-sized images have to be scaled down for better processing, especially for the grain detection task. Therefore, it is strongly recomended to scaledown the images if the grain detection detects only partial parts of the grains.


Structure Finding (2_2_1_2_1_DSC09841)

(a) Processing progress



Structure Finding Process finished.

(b) Structure processing notification message

Figure 10: Structure detection notifications

2.7 Working with the Panicle Structure

This section describes how to find the structure both for a single image and for all images in the project.

2.7.1 The Structure of a Single Image

To process a single image in order to find the structure, do the following:-

1. Select the image file and right click to open the pop up menu, Figure 5b.
2. Choose *Find Structure*

During processing the panicle image, a progress bar in the *status panel* of the main window shows the current situation, Figure 10a. When the processing finished the system will notify you by a message as shown in Figure 10b.

When the processing finished, a structure file will be added to the *result/images* folder, Figure 11.

2.7.2 The Structure of Multiple Images

1. Select the project
2. Click on button.

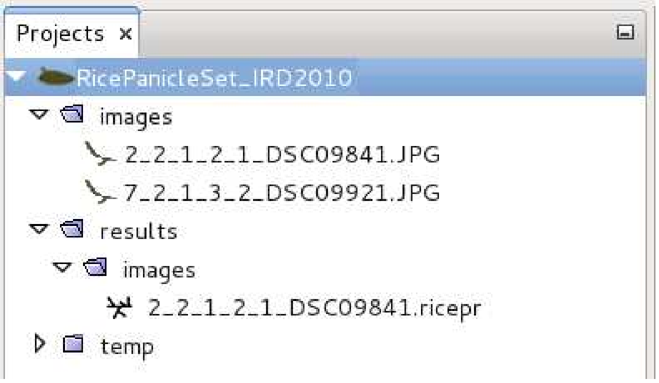


Figure 11: A structure file generated after the image processed

2.7.3 View and Edit the Structure

This is a very important task because it allows the user to manipulate the structure. To view the structure of a given image do the following:-

1. Double click on the structure file in the project, or
2. Right click on the image, a context pop-up menu appears, choose *View/edit results file* menu item.

Use the key-mouse *ctrl+ mouse wheel* combination to zoom in/out the scene. To move the entire scene hold the *mouse wheel* down and move the mouse.

To edit the structure, Table 2.1 shows the required key/mouse combinations:-

Table 2.1: Structure editing key/mouse combinations

Functionality	Command
Add a circle	Double click
Delete a circle	Right click then choose *Delete*, Figure 12
Connect two circles	Hold *ctrl* key down then while pointing on one circle drag the mouse
Remove a link	Click on the link, then move one of its ends to an empty place
To change the type of a circle	Right click then choose the type you want, see Figure 12

Due to the variation from one panicle to another, **the user has to define the start and end generating points (yellow-colored circles)**. This is described in details in Figure 12:-

During post processing the results, the application will show hint if some circles need to be connected, Figure 13.

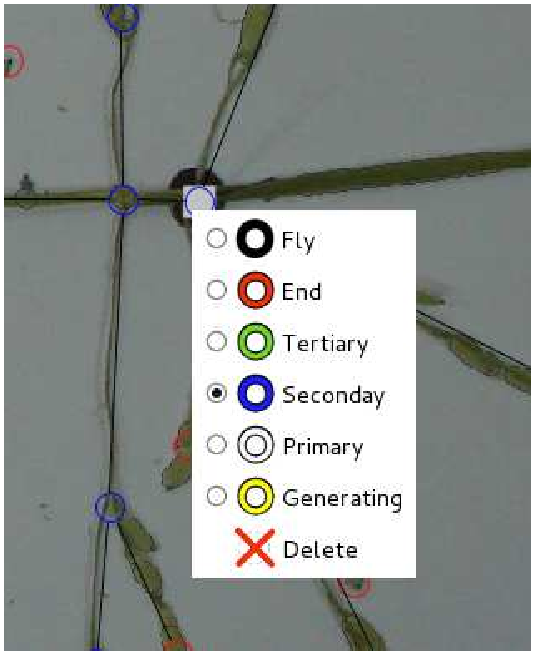


Figure 12: Circles context menu

Once you finished the editing and specifying the start and end generating circles, click 💾 to save the changes you have made.

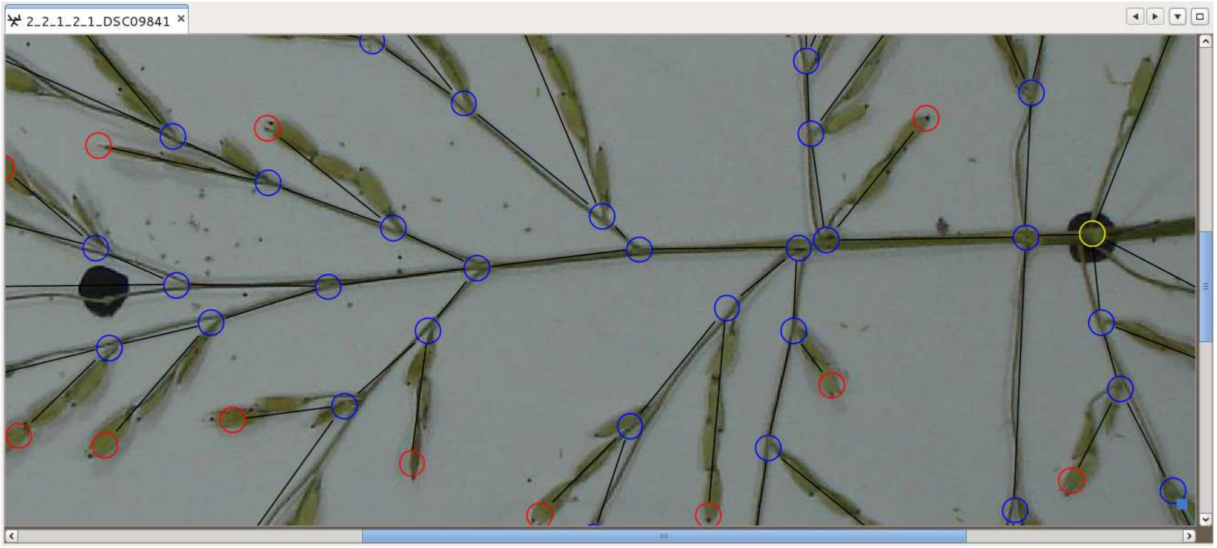
2.8 Working with the Grains

There are two methods to detect the grains. The first one deals with the clustered grains and is able to detect the grains on the branches. The other method deals with separated grains. This section deals with both cases. In the beginning we explain how to find the grains of a single image, then the post-processing is explained.

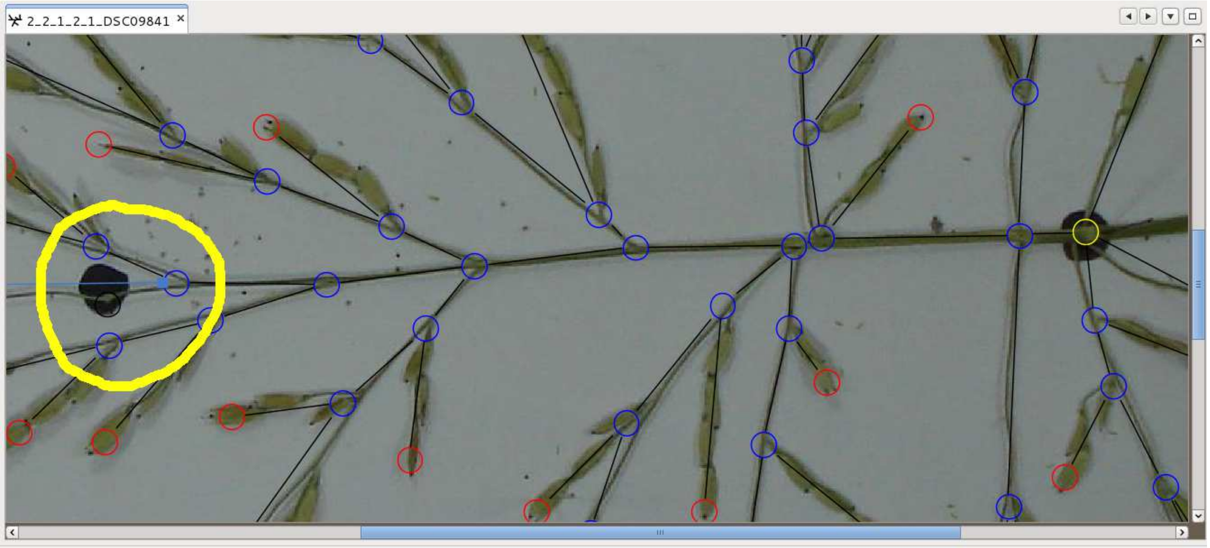
2.8.1 Detecting the Grains in a Single Image

To process a single image in order to find the grains, do the following:-

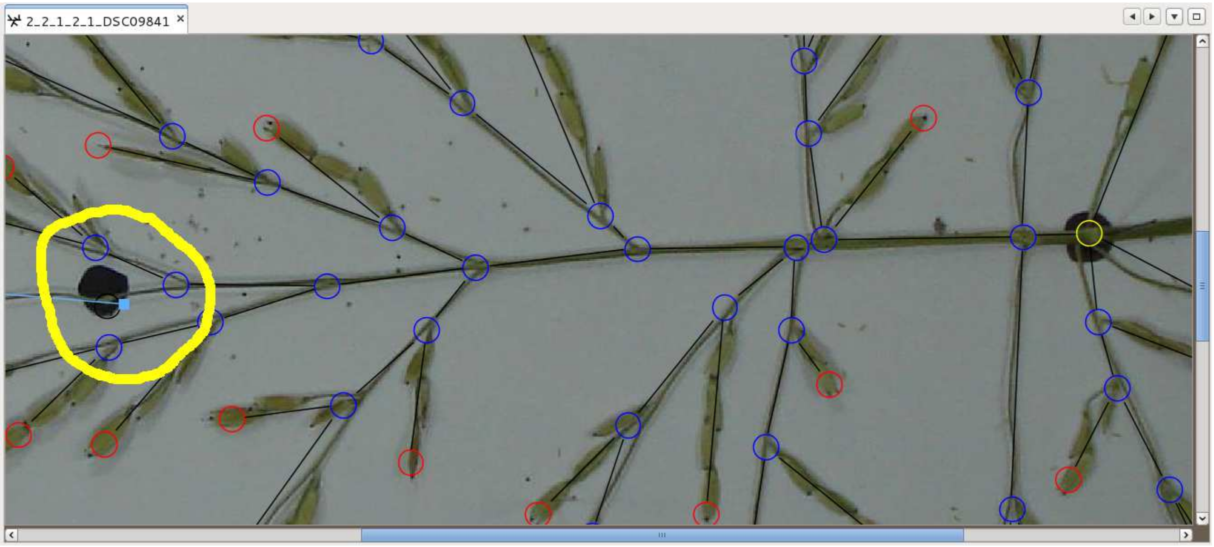
1. Select the image file and right click to open the pop up menu, (Chapter 1, Figure 5b).
2. Choose *Find Grains* if the image has clustered grains, otherwise choose *Find Grains' Traits*


2_2_1_2_1_DSC09841

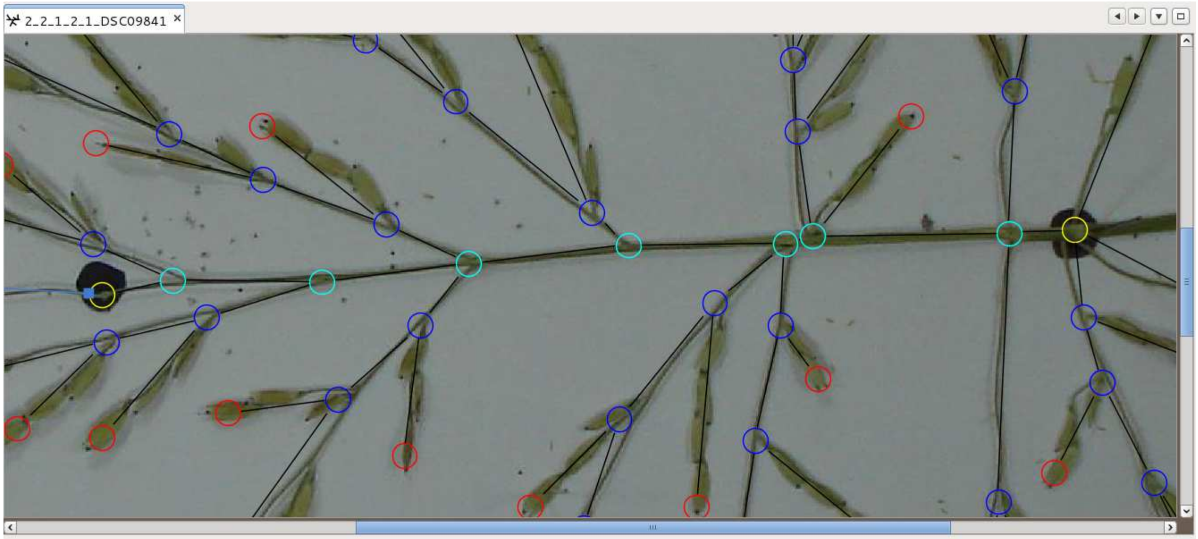
(a) Select the start generating circle, right click, and then choose *Generating* from the menu


2_2_1_2_1_DSC09841

(b) If the end generating point is not detected, double click to create a *flying* circle (*i.e* black)


2_2_1_2_1_DSC09841

(c) Connect the new circle



(d) Right click on this new “connected” circle and choose *Generating* from the menu

Figure 12: Defining the start and end generating circles

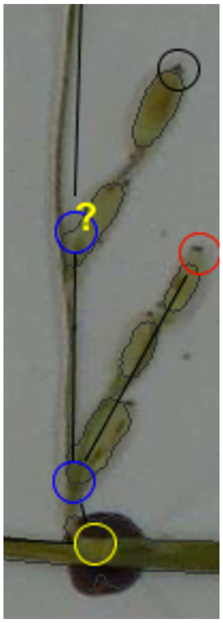


Figure 13: An error hint generated by the application to allow the user locate the error easily.

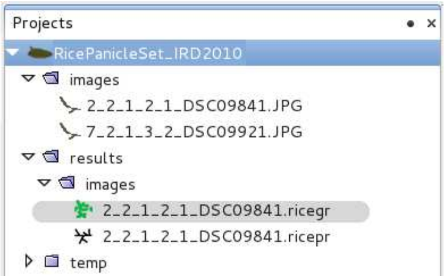

Projects
RicePanicleSet_IRD2010
images
2_2_1_2_1_DSC09841.JPG
7_2_1_3_2_DSC09921.JPG
results
images
2_2_1_2_1_DSC09841.ricegr
2_2_1_2_1_DSC09841.ricepr
temp

Figure 14: A grains file generated from processing a panicle image.

Once the application finished finding the grains, it will notify the user by a message. As a result, a grain file will be generated as shown in Figure 14.

2.8.2 Detecting the Grains in Multiple Images

1. Select the project.
2. Click button, if the grains are clustered. Otherwise click button.

A progress bar will appear in the right bottom of the main window to show the percentage of images being processed. Once it finished, it will show a notification message.

2.8.3 Color-Segmentaion for grains detection

In some cases, the main automatic segmentaton method may have problems finding the acurate bounds of the grains. For this porpose a manual-guided method is available. In this method, the user has to specify the grain and background colors. To define these colors:

- Open the image in the *image editor*.
- *Right-click* to open a pop up menu as shown in Figure 8.
- select the colors.

To run in color-segmentation mode, toggle ON the *color segemention*,

2.8.4 View/Edit the Grains Files

To view a grain file do one of the following:

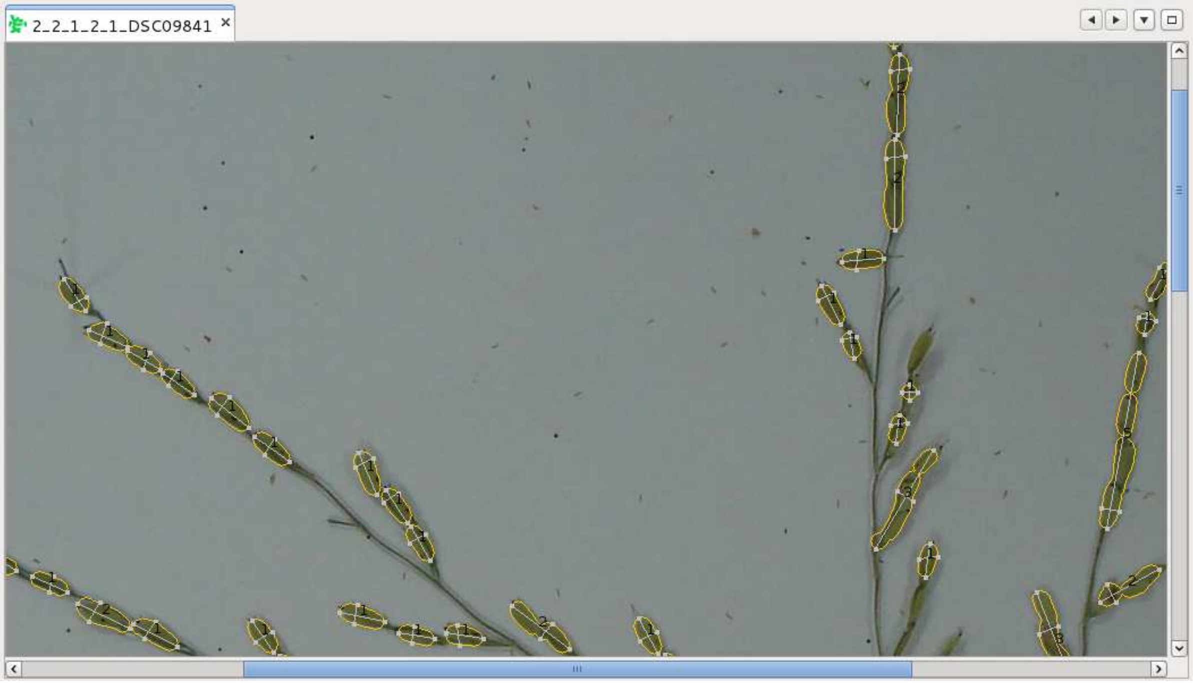


Figure 15: The anchors of the grains.

1. Double click on the grain file in the project, or
2. Right click on the image, a context pop-up menu appears, choose *View/edit grains file*.

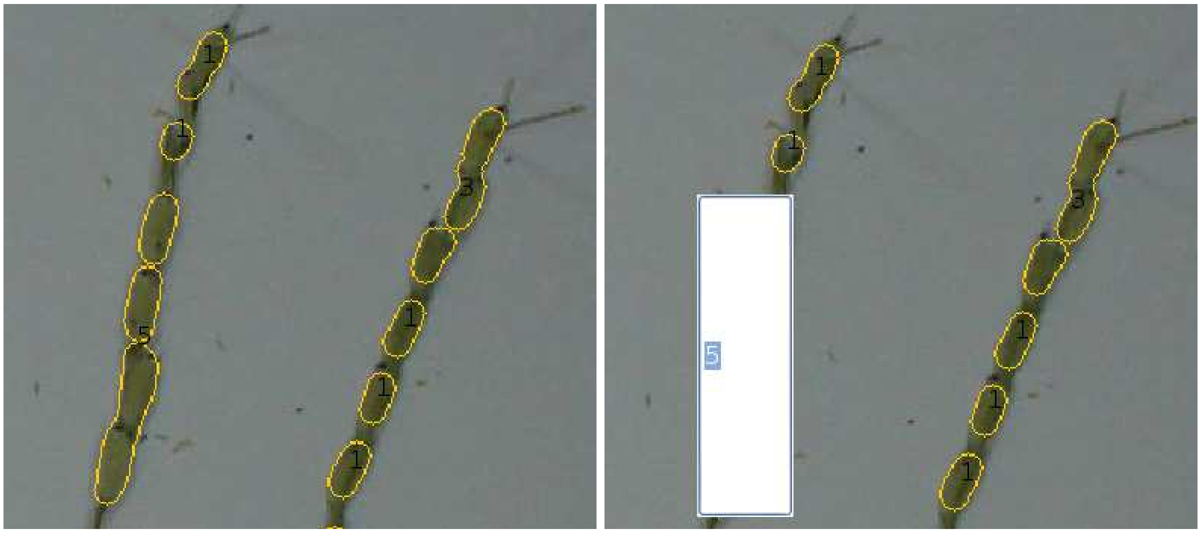
To view the the grains major and minor axes, Figure 15, toggle the *View Anchors* button *ON*.

Editing the grains file includes adding, removing, and correcting the number of grains. To add a grain, right click in the place you want to add a grain and then choose *add grain*. To remove a grain or a grains' cluster, right click on the grain and then choose *remove grains*. For modifying the number of grains, double click on the grain then write the correct number of grains, Figure 16.

Once you finish post-processing the grains, click the save button to save the changes you have made.

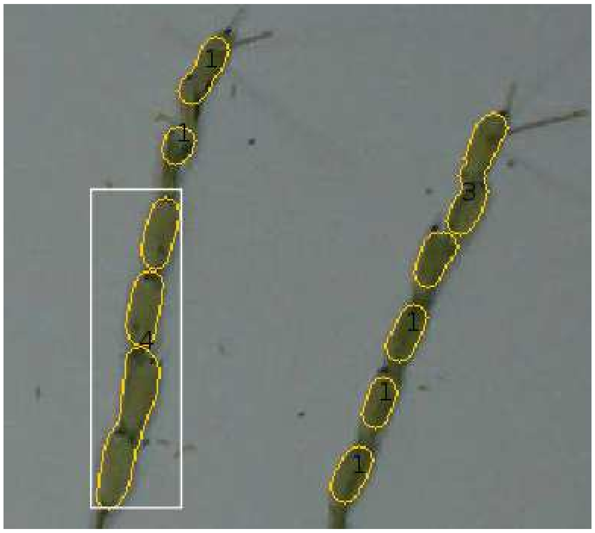
2.9 Collecting the Reports

As mentioned before, P-TRAP generates three reports in Comma Separated Values (CSV) format. Once the processing and post-processing tasks are performed, the final reports can be


1
1
5
3
1
1
1
1
1
5
3
1
1
1

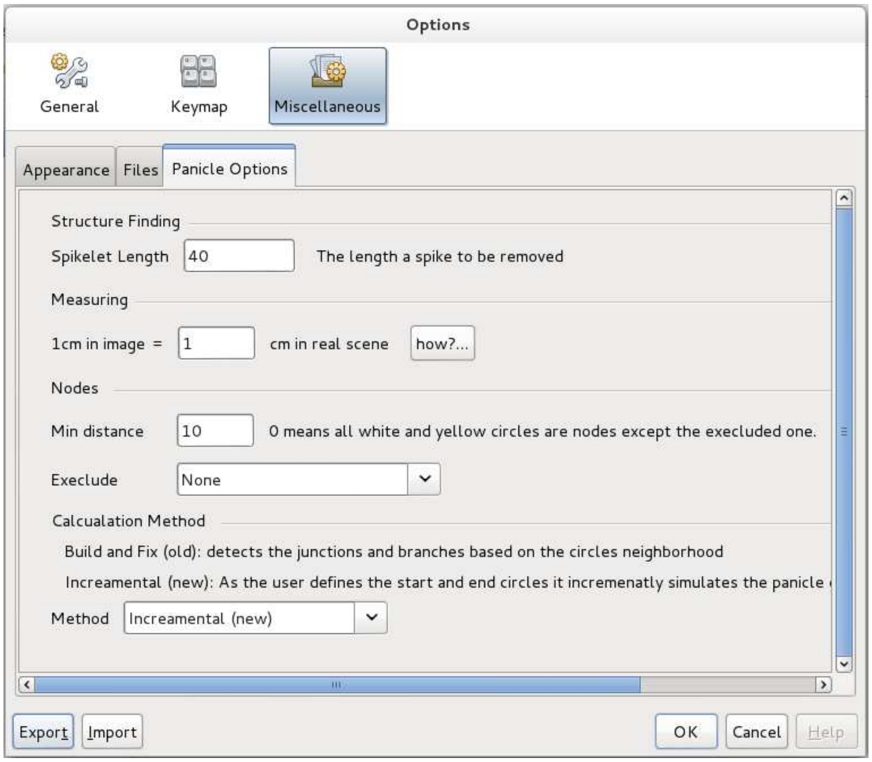
(a) Incorrect number of grains

(b) Edit the number of grains



(c) Corrected number of grains

Figure 16: Grains number correction.



Structure Finding

Spikelet Length 40 The length a spike to be removed

Measuring

1cm in image = 1 cm in real scene

Nodes

Min distance 10 0 means all white and yellow circles are nodes except the execluded one.

Execlude None

Calcualation Method

Build and Fix (old): detects the junctions and branches based on the circles neighborhood

Increamental (new): As the user defines the start and end circles it incremenatly simulates the panicle

Method Increamental (new)

Figure 17: The panicle options dialog

generated by:

1. Select the project
2. Click ▦ button.

When the application finished collecting the results of all images, it will notify the user by a message. The reports files are shown in Figure 10.

2.10 Options

P-TRAP offers a set of options for the graphical interface and the core process as well. This sections describes the processing options. The panicle options can be found in: *Tools* ⟶ *Options* menu, then choose *Panicle Options*, Figure 17. These options are explained in Table 2.2.

Table 2.2: P-TRAP panicle options

Option	Description
Structure Finding	
Spikelet Length	Controls the minimum length of the branch, any branch that has length less than this value will be mark as a noise and removed.
1cm	This option defines the ratio between the cm in the image and in th real panicle.
Nodes	
Min distance	Controls the minimum distance between two nodes in the main axis in the panicle. If the distance between two nodes is less than this value they are counted as a single node.
Exclude	Which nodes has to be excluded from counting?
Calculation Method	
Method	Which method that applications has to use in order to detect the panicle structure? Usually the incremental method works better.

2.10.1 Defining the Scale

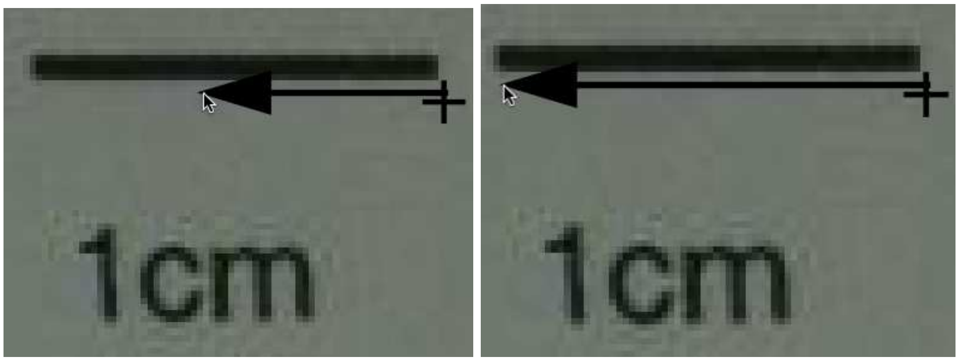
The scale label is widely used in many biological work. P-TRAP allows the user to define the measuring scale in the image. The following steps explain how to define the measuring scale.

1. Open the image that contains the scale by double-clicking on the image.
2. Drag from the one end of the scale, Figure 18a, and hold until you reach the other end then right click, Figure 18b.
3. The scale dialog appear, Figure 18c define how many unite in the scale and click *OK*.

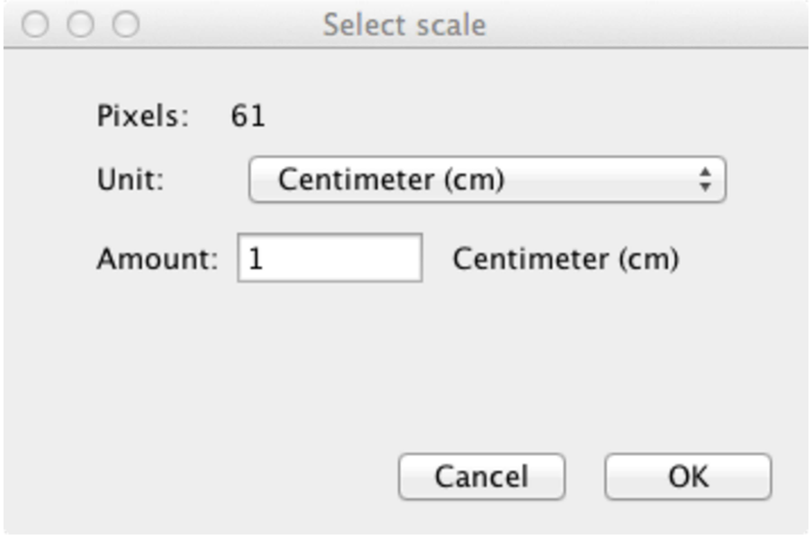
The application will then use the ratio between the real panicle size and the panicle size in the image to make accurate calculations.

2.10.2 Image's Background

In some cases, the images backgrounds are darker than the objects. Therefore, P-TRAP offers an option such that the user defines the type of the image's background. The default option is white, you can change it to dark by toggling the *Dark Background* button ✱ *ON*.



(a) Drage on one end of the scale (b) Righ-click once the other end is reached



Pixels: 61

Unit: Centimeter (cm)

Amount: 1 Centimeter (cm)

(c) Define how many unites in the scale

Figure 18: Defining the scale in image.

3 Troubleshooting

- *Not very good detection.*

  1- Try to scale down the images if they are very large or crop the unwanted background or artifacts at the borders.

  2- If the background is dark try to use the **dark background** ✱ option.

- *Unable to save the detected structure.* Try to remove all flying circles (black colors) you can use the right-click menu to remove them all. Also make sure you have determined the start and end generating points.

- *The report is empty.* Make sure you have defined the start and end generating points in the structure.

Appendix A

XML Files

1 Structure XML File

The structure XML file is compactly describing the structure of the panicle as a mathematical graph composed of vertices and edges. What is needed to use this file is any XML parser plugged in your application to convert this file into your graph data structure, by tackling only the <graph> entity and its components. The entire structure of the file is described as the following:

- <**result signature="STRUCTUE" imagepath="18_2_2_1_2_DSC09873.JPG"**>

  The is the main tag, which means this is a structure result file identified by the signature, "STRUCTURE".

- <**graph**> Describes a graph of vertices and edges, this graph represents the panicle structure.

- <**vertices**> contains a set of vertices (these are converted to cycles as you can see them in the application). They describ the junctions and the ends of the panicle structure.

- <**vertex id="java.awt.Point[x=994,y=1282" x="994" y="1282" type="End" fixed="false"/**> A single vertex. Its attributes are:-

  - **id**: an identifier of the vertex,

  - **x and y**: the xy-coordinates of the vertices,
  - **type**: the type of the vertex,
  - **isfixed**: true if the vertex has been edited by the user.

- <**edges**> The edges that connects the graph vertices
- **<edge vertex1="java.awt.Point[x=1047,y=1053]" vertex2="java.awt.Point[x=1149,y=1015]"/>** an edge that connects two vertices given their identifiers "vertex1" and "vertex2".